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DRI Data Resources

June 1987

32nd Annual McGraw-Hill Survey of Research and Development Expenditures, 1987-89

Corporate commitment to research and development (R&D) spending in the United States is on the wane. Ever since a brief 1984 rebound from the 1982 recession, research and development budgets have steadily softened. According to the latest DRI/McGraw-Hill survey, R&D spending by American industry is projected to advance only 4.9%, to $87.0 billion, in 1987. Looking further ahead, survey respondents foresee a slight increase of 3.7% from 1987 to 1989 (Table I*).

Although these figures are not adjusted for inflation, real, or constant-dollar, R&D investment also appears troubled. After posting a 10.1% gain in 1985, nominal research and development investment

Chart 1
Research and Development Spending by All Businesses
(Billions of dollars)

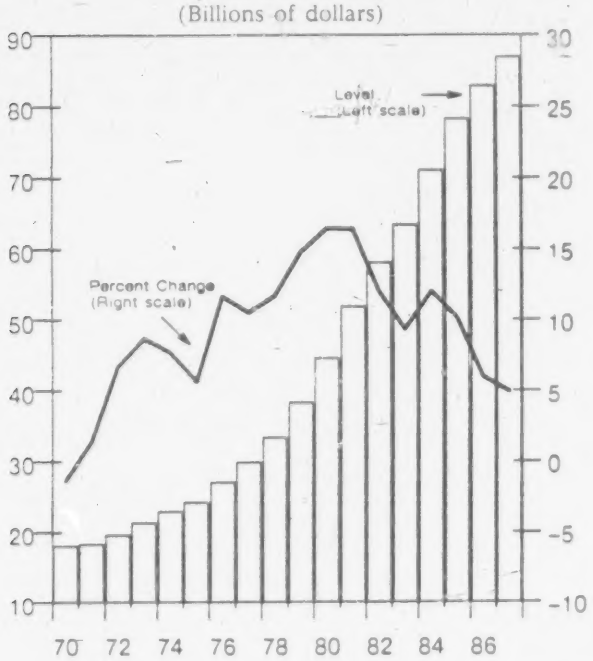
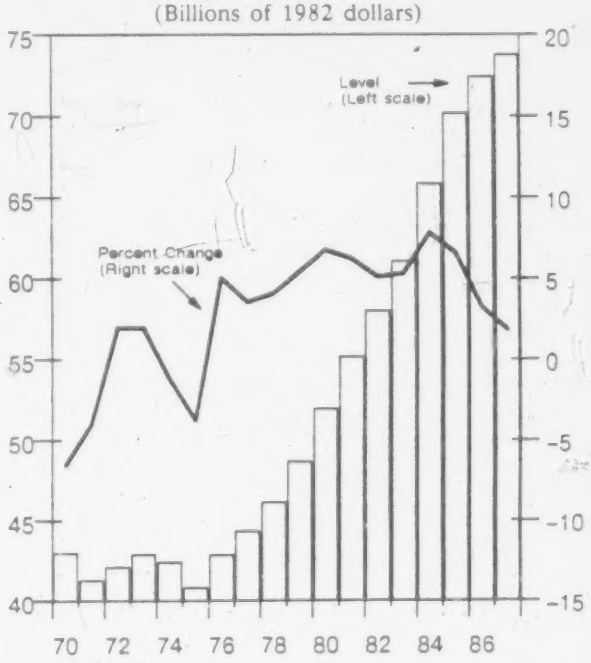
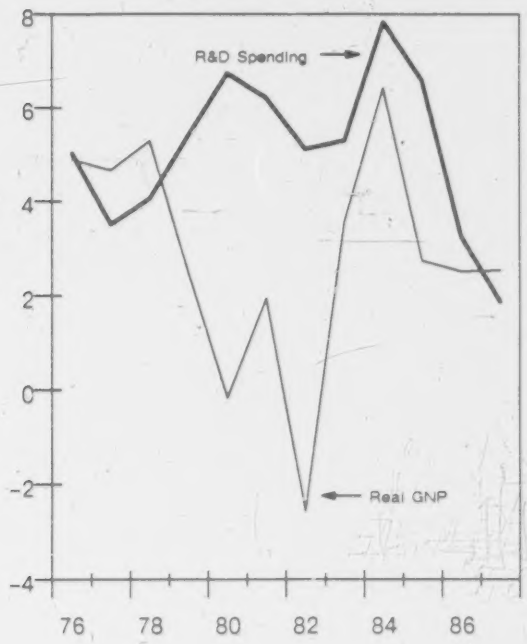


Chart 2
Real Research and Development Spending by All Businesses
(Billions of 1982 dollars)



*Tables denoted by Roman numerals appear at the end of this report.

Chart 3
Growth in Real Research and Development Spending and Real Gross National Product
(Percent change)



rose only 6.0% in 1986. Meanwhile, a constant-dollar spending advance of 6.7% in 1985 was nearly halved to a 3.4% real growth rate in 1986. As inflation accelerates in 1987, the 4.9% nominal gain should shrink to an uptick of roughly 1.9%. This will be the first time since 1977-78 that the real rate of research and development investment growth has slipped below real GNP growth, projected by DRI at 2.5% in 1987.

These are the key findings of the 32nd Annual DRI/McGraw-Hill Survey of Research and Development Expenditures, 1987-89. The survey was conducted in April and May and drew responses from 463 companies replying to a broader poll of capital spending plans. All dollar figures in this report have been adjusted to represent R&D spending by all U.S. companies and reflect domestic investment only. In addition, this report includes funds provided by the government but spent by private companies.

IS IT THE TIME FOR AN R&D SLOWDOWN?

Between 1976 and 1985, after the mid-1970s recession, U.S. business pumped 12.5% average annual increases into their research and development budgets (Table V); in real terms, this was a 5.6% average

Chart 4
Growth in Research and Development Spending
(Percent change)

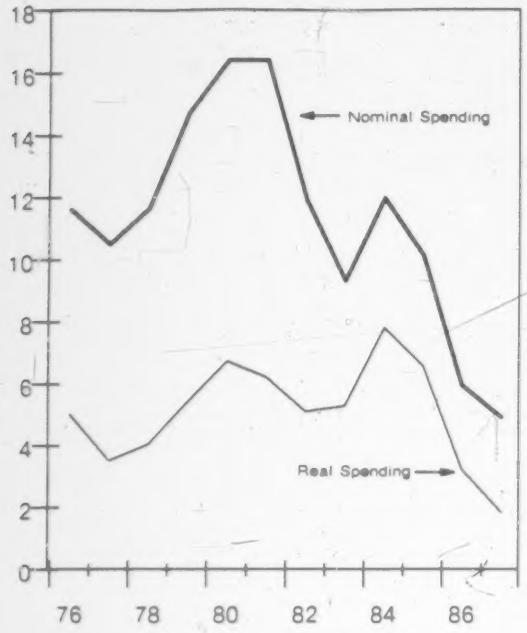
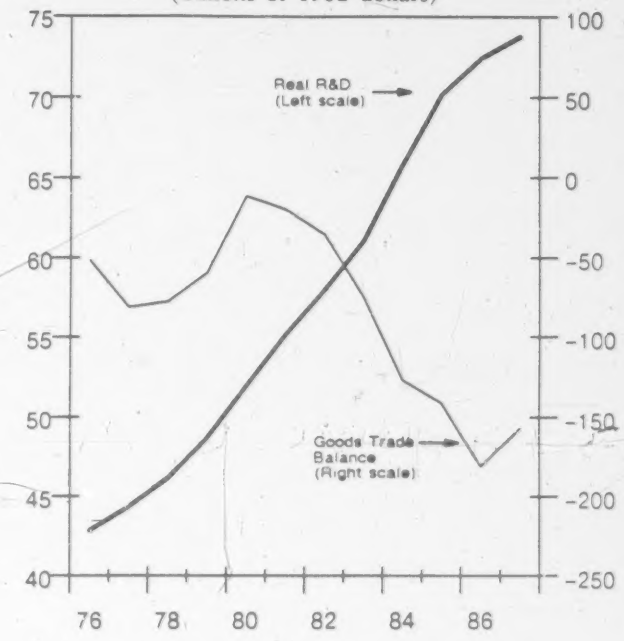


Chart 5
Real Research and Development Spending and the Goods Trade Balance
(Billions of 1982 dollars)



annual gain. Almost simultaneously, the nation's trade balance began to erode, hurt by a strong dollar; the U.S. merchandise trade balance had tumbled to a net deficit of $148.1 billion by the end of 1986.

Since the spring of 1985, the dollar has declined 33% in real terms and the trade deficit seems to have finally reached a turning point. While rising import prices have sent nominal trade balances deeper into the red, real trade flows are rapidly improving. Measured in constant 1982 dollars, the goods and services deficit narrowed from an annualized rate peak of $163 billion last summer to $137 billion in the first quarter of 1987. Steady progress in trade should continue throughout the year and eventually reverse the nominal trade deterioration.

While the yawning trade deficit is good reason for businesses to bolster R&D budgets, they have not done so, opting for the easier short-term competitive solution of holding prices down as the dollar falls. Increasingly, U.S. industry is battling the East Asian nations (Korea, Taiwan, Hong Kong) for market share--countries whose currencies rise and fall with the dollar. Ultimately, true competitiveness will derive from the innovation of new products and technology spawned from research and development efforts.

While it is unlikely that the lull in R&D commitment is due entirely to the weaker dollar, there is little consensus as to the primary catalyst. A general economic environment of sluggish growth, guarded sales expectations, and short-term profitability strategies seem to permeate U.S. corporate planning, possibly the result of the volatility stirred by the run of corporate mergers, restructuring, and takeovers. Moreover, tax reform lowered the R&D tax credit from 25% to 20% and threatens to eliminate it at the close of 1988. DRI, however, expects the R&D credit to survive in some form.

SOME RATIOS LOOK GOOD

When compared with sales measures, manufacturers' research and development budgets do not appear quite as tight. After hovering between 2.8% and 2.9% of sales during the 1960s, research and development investment was curtailed sharply during the mid- to late 1970s. While the R&D-to-sales ratio was mired at a record low of 2.1% between 1977 and 1979 (Table VII), it reached a record high of 3.0% by 1983. If respondents' R&D and sales expectations prove correct, the ratio should hold to its new high of 3.5% in 1987 for the second consecutive year (Table IV).

Chart 6
Research and Development Spending by All Manufacturing Industries as a Percent of Sales

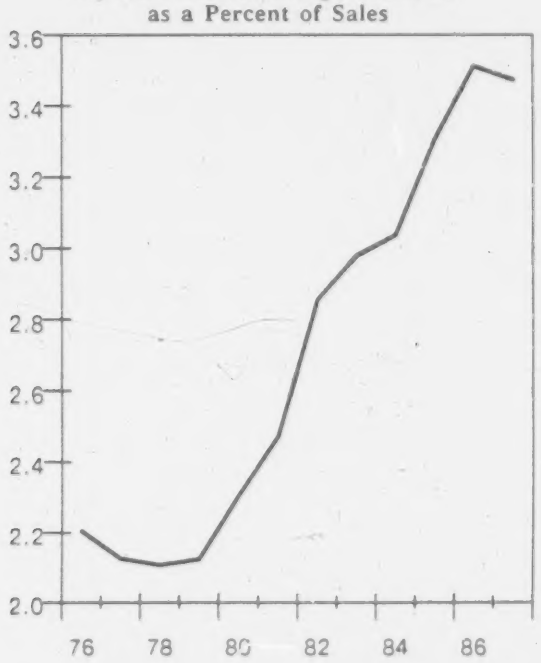
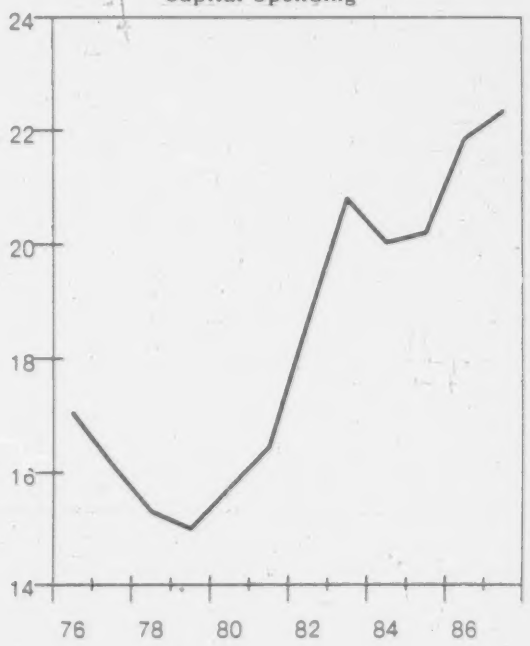


Chart 7
Research and Development Spending by All Businesses as a Percent of Capital Spending



R&D investment also looks more favorable when compared with capital investment. This ratio peaked in 1963 when research and development spending approached 29% of capital budgets for all U.S. business (Table VI); for manufacturers alone, R&D reached a staggering 71.5% of capital investment. By 1979, however, R&D reached its nadir: U.S. business sank the equivalent of 15% of capital expenses into R&D projects, with manufacturers hovering at a 38% ratio. According to the current survey, 1987 should witness an R&D-to-capital investment ratio of 22.3% for all business (Table III). For manufacturers, the ratio should top 57%, although this figure is somewhat misleading. Capital spending by manufacturers has fluctuated dramatically over the last few years. A 10.6% jump in 1985 and a 7.0% plunge in 1986 were largely responsible for the improved R&D-to-capital investment ratio in 1986. Consequently, continued weakness in capital investment plans will more than offset lackluster R&D spending, implying a stronger ratio than the underlying components demonstrate individually.

R&D SPENDING BY SECTOR

Research and development spending growth by the nonmanufacturing sector will easily outpace spending by manufacturers over the next few years, as it has since 1983. Nonetheless, this represents relatively small dollar amounts, since manufacturers account for roughly 96% of all R&D spending by U.S. business.

The aerospace industry historically leads all manufacturers in research and development outlays, aided greatly by heavy funding from the Pentagon for weapons system research and development. While the industry has regularly shown healthy year-to-year increases on the strength of this government support, the rules are changing. The Competition in Contracting Act of 1984 is forcing companies to front more of their own money, at least initially, to fund Department of Defense R&D aerospace projects. Any defense budget paring by Congress could further hamper aerospace's R&D outlays. After supporting increases of 8.9% and 6.2% in 1985 and 1986, respectively, the industry looks toward a 5.8% gain in 1987. Aerospace company respondents expect R&D spending to drop 1.6% below 1987 levels by 1989 (Table II).

Electrical machinery makers, the other large R&D sector player, also show signs of scaling back future research. Increases of 11.8% in 1985 and 5.1% in 1986 will be trailed by a modest 2.9% gain in 1987. Manufacturers of electric distributing equipment, household appliances, and electronic components show the most optimism, while electrical industrial apparatus makers expect a slight cut in R&D budgets in 1987, followed by an 11.4% gain by 1989. Communication equipment makers plan most of their R&D increases in 1988 and 1989.

After a slim gain of 2.8% last year, nonelectrical equipment manufacturers expect their R&D budgets to slip 0.3% in 1987. Computer makers are still cautious after the poor sales performance of the last few years, but expect a 10% increase between 1987 and 1989--still well below the annual double-digit increases typical of this heavily R&D-dependent industry. Metalworking machinery makers revealed ambitious research and development plans, while farm, construction, and industrial equipment manufacturers expect further cutbacks.

Elsewhere within manufacturing, chemical companies plan to increase R&D funding some 5% in 1987 after barely managing 2% growth in 1986. The automotive industry expanded its outlays nearly 16% in 1985 and 14.2% in 1986, but R&D spending will slow to a 7.0% gain in 1987 and show zero growth through 1989. Instrument makers will continue to ease the growth of research and development budgets, which slip from 7.7% in 1986 to 6.3% in 1987. Makers of medical instruments buck this trend, however, forecasting extremely vibrant R&D increases.

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Table I
Research and Development Expenditures
(Millions of dollars)

Industry	1985 Actual	1986 Estimated	Planned 1987	Planned 1989	Percent Change 1986-87	Percent Change 1987-89
Iron & Steel	605	643	670	749	4.3	11.7
Nonferrous Metals	585	654	667	666	2.0	-0.2
Electrical Machinery	17,081	17,950	18,467	19,973	2.9	8.2
Non-Electrical Machinery	10,870	11,177	11,142	11,288	-0.3	1.3
Autos, Trucks & Parts	7,058	8,062	8,626	8,626	7.0	0.0
Aerospace	17,466	18,549	19,624	19,315	5.8	-1.6
Fabricated Metals	697	742	797	867	7.5	8.7
Instruments	5,420	5,835	6,203	6,459	6.3	4.1
Stone, Clay & Glass	587	668	675	677	1.0	0.4
Lumber & Furniture	172	254	271	294	6.6	8.7
Chemicals	8,674	8,846	9,289	10,164	5.0	9.4
Paper & Pulp	863	857	912	966	6.4	5.9
Rubber & Plastics	1,187	1,295	1,440	1,564	11.2	8.6
Petroleum	2,185	2,200	2,537	2,578	15.3	1.6
Food & Beverage	820	922	990	1,056	7.3	6.7
Textiles	158	167	170	173	1.7	1.8
Other Manufacturing	922	998	1,128	1,197	13.0	6.1
ALL MANUFACTURING	75,350	79,619	83,608	86,611	4.7	3.6
ALL NONMANUFACTURING	2,867	3,069	3,370	3,566	9.8	5.8
ALL BUSINESS	78,217	82,887	86,978	90,177	4.9	3.7

Table II
Detailed Industry Data

	Research & Development Percent Change		
	1985-86	1986-87	1987-89
Durables			
Iron & Steel	6.1	4.3	11.7
Nonferrous Metals	11.7	2.0	-0.2
Primary Nonferrous Metals	12.8	2.2	-0.2
Nonferrous Rolling and Drawing	-0.1	0.0	0.1
Electrical Machinery	5.1	2.9	8.2
Electric Distributing Equipment	7.5	4.2	4.2
Electrical Industrial Apparatus	-31.1	-1.4	11.4
Household Appliances	79.4	32.0	14.0
Electric Lighting and Wiring	0.7	0.0	0.0
Communication Equipment	-2.7	0.9	14.5
Electronic Components	16.2	8.3	8.3
Misc. Electrical	-18.1	11.4	16.8
Non-Electrical Machinery	2.8	-0.3	1.3
Engines and Turbines	-23.6	0.4	9.6
Farm Equipment	-2.5	-0.5	2.9
Construction, Mining, Materials Handling Eq.	-8.1	-5.1	-3.6
Metalworking Machinery	20.6	12.2	11.1
Special Industry Machinery	-6.2	-6.9	-6.4
General Industrial Machinery	0.4	-13.9	-8.7
Office, Computing Machinery	5.5	2.5	10.0
Refrigeration and Service Industry Machinery	20.2	10.6	6.8
Autos, Trucks & Parts	14.2	7.0	0.0
Aerospace	6.2	5.8	-1.6
Fabricated Metals	6.4	7.5	8.7
Cutlery, Hand Tools, Hardware	11.2	13.6	14.6
Plumbing and Heating Eq.	-14.3	10.0	10.0
Fabricated Structural Metal	5.1	7.2	8.1
Screw Machine Products	4.5	5.0	5.0
Misc. Fabricated Metals	13.1	9.1	23.0
Instruments	7.7	6.3	4.1
Engineering & Scientific Instruments	-8.0	2.7	3.8
Optical Instruments and Lenses	1.8	-9.9	-9.9
Medical Instruments and Supplies	88.9	18.5	18.5
Stone, Clay & Glass	13.7	1.0	0.4
Products of Purchased Glass	16.8	-4.0	0.5
Cement, Hydraulic	0.0	0.0	0.0
Structural Clay Products	15.3	15.2	0.0
Misc. Nonmetallic Mineral Products	10.8	-5.0	0.3
Other Durables	20.1	6.2	16.4
Lumber	47.8	6.6	8.7
Ships & Boats	34.8	NA	NA

Table II (Continued)

	Research & Development Percent Change		
	1985-86	1986-87	1987-89
Nondurables			
Chemicals	2.0	5.0	9.4
Industrial Inorganic Chemicals	19.5	10.2	19.4
Drugs	2.3	12.6	20.1
Soap, Cleaners, & Toilet Goods	4.7	11.5	7.8
Paints	6.9	7.0	8.0
Agricultural Chemicals	48.0	1.5	1.0
Misc. Chemicals	3.3	8.0	7.2
Paper & Pulp	-0.7	6.4	5.9
Paper Mills	-0.5	12.8	11.0
Converted Paper Prod.	37.5	12.0	12.0
Paperboard Containers	2.5	13.3	10.9
Rubber & Plastic	9.1	11.2	8.6
Miscellaneous Plastics Products	18.4	15.0	30.0
Petroleum	8.7	15.3	1.6
Food & Beverage	12.6	7.3	6.7
Preserved Fruits and Vegetables	22.6	40.0	0.0
Beverages	7.8	14.8	25.0
Textiles	6.3	1.7	1.8
Weaving Mills, Cotton	0.0	3.0	4.0
Knitting Mills	-9.7	4.0	4.0
Other Nondurables	7.2	13.5	5.2
Tobacco	7.9	13.6	5.1
Apparel	0.0	5.0	10.0
Printing and Publishing	-3.8	10.0	10.0
Leather	5.4	12.7	7.9
Nonmanufacturing			
Mining	-7.1	1.4	-4.5
Metal Mining	-11.8	5.0	-10.0
Bituminous Coal	7.4	27.0	9.0
Oil & Gas Extraction	-2.2	-29.5	16.0
Oil well Services	-0.6	-30.0	15.0
Electric Utilities	-0.4	18.6	11.4
Gas & Other Utilities	281.8	-32.7	-18.0
Communications	3.8	12.4	7.5
Telephone Communications	3.8	12.8	7.4
Trade & Services	4.0	4.0	1.2
General Building Contractors	29.5	5.0	5.0
Heavy Construction Contractors	-56.9	10.0	25.0
Retail and whole. Trade	74.5	93.3	0.0
Hardware, Plumbing Eq.--whole	-1.5	0.0	0.0
General Merchandise Stores	90.1	103.4	NA
Food Stores	0.0	0.0	0.0
Finance	10.6	0.1	10.0
Insurance Carriers	17.4	10.0	10.0
Personal & Business Services	7.2	1.2	1.0
Hotels and Motels	NC	15.0	15.0
Business Services	7.1	1.1	1.0
Computer and Data Processing Services	13.7	7.5	8.7
Miscellaneous Business Services	0.4	0.3	0.2
Health Services	-3.4	63.4	4.1
Miscellaneous Professional Services	-3.4	63.4	4.1

Table III
Research and Development as a Percent of Capital Spending

Industry	1986	1987
Iron & Steel	19.2	16.7
Nonferrous Metals	34.0	30.8
Electrical Machinery	127.4	128.3
Non-Electrical Machinery	82.0	75.7
Autos, Trucks & Parts	57.7	68.2
Aerospace	487.8	482.4
Fabricated Metals	18.5	23.2
Instruments	236.0	231.0
Stone, Clay & Glass	21.4	21.4
Chemicals	52.8	50.9
Paper & Pulp	9.8	10.0
Rubber & Plastic	33.0	49.0
Petroleum	12.1	14.5
Food & Beverage	8.7	10.1
Textiles	10.1	9.8
Other Manufacturing	5.5	5.6
ALL MANUFACTURING	55.9	57.4
ALL NONMANUFACTURING	1.3	1.4
ALL BUSINESS	21.9	22.3

Table IV
Research and Development as a Percent of Sales

Industry	1986	1987
Iron & Steel	1.5	1.3
Nonferrous Metals	1.3	1.2
Electrical Machinery	8.7	8.6
Non-Electrical Machinery	5.1	5.5
Autos, Trucks & Parts	4.1	NA
Aerospace	18.7	19.0
Fabricated Metals	0.5	0.5
Instruments	3.6	3.5
Stone, Clay & Glass	1.2	1.1
Chemicals	4.5	4.1
Paper & Pulp	0.8	0.8
Rubber & Plastic	1.8	1.8
Petroleum	1.7	1.9
Food & Beverage	0.3	0.3
Textiles	0.3	0.3
Other Manufacturing	0.4	NA
ALL MANUFACTURING	3.5	3.5

Table V
Historical Research and Development Expenditures
(Millions of dollars)

Industry	1953	1954	1955	1956	1957	1958	1959	1960
Iron & Steel	42	44	46	55	64	80	84	102
Nonferrous Metals	20	25	28	35	44	51	68	75
Non-Electrical Machinery	330	358	455	543	669	781	930	949
Electrical Machinery	817	904	983	1,516	1,804	1,969	2,329	2,532
Aerospace	829	999	1,285	2,138	2,574	2,609	3,090	3,514
Autos, Trucks & Parts	495	531	561	688	707	856	866	884
Fabricated Metals	52	55	65	116	135	162	138	145
Instruments	178	195	176	200	249	294	309	329
Stone, Clay & Glass	40	45	46	60	69	75	81	88
Lumber & Furniture	10	10	10	10	14	12	12	10
Chemicals	374	407	445	641	705	792	891	980
Paper & Pulp	29	33	32	36	35	42	49	56
Rubber & Plastic	54	65	79	105	107	89	115	121
Petroleum	149	167	172	182	211	246	278	296
Textiles	10	12	12	12	15	26	30	38
Food & Beverage	54	61	70	64	74	83	91	104
Other Manufacturing	53	58	64	74	93	105	118	119
ALL MANUFACTURING	3,536	3,969	4,529	6,475	7,569	8,272	9,479	10,342
ALL NONMANUFACTURING	94	101	111	130	162	117	139	168
ALL BUSINESS	3,630	4,070	4,640	6,605	7,731	8,389	9,618	10,510

Industry	1961	1962	1963	1964	1965	1966	1967	1968
Iron & Steel	98	97	106	116	128	139	135	135
Nonferrous Metals	79	74	77	79	85	93	107	115
Non-Electrical Machinery	901	914	958	1,015	1,165	1,217	1,326	1,483
Electrical Machinery	2,483	2,639	2,866	2,972	3,200	3,626	3,867	4,283
Aerospace	3,829	4,042	4,712	5,078	5,148	5,526	5,669	5,765
Autos, Trucks & Parts	936	999	1,090	1,182	1,230	1,344	1,354	1,499
Fabricated Metals	136	146	153	148	145	154	163	183
Instruments	297	309	284	331	403	468	542	663
Stone, Clay & Glass	88	96	100	109	112	117	136	142
Lumber & Furniture	10	10	11	12	11	12	12	20
Chemicals	1,101	1,175	1,239	1,284	1,356	1,407	1,507	1,589
Paper & Pulp	59	65	69	77	94	117	128	144
Rubber & Plastic	138	141	156	158	162	168	182	223
Petroleum	299	310	317	393	397	371	371	437
Textiles	30	28	30	32	38	51	57	58
Food & Beverage	125	121	130	144	157	164	183	184
Other Manufacturing	105	65	54	65	71	77	90	101
ALL MANUFACTURING	10,714	11,231	12,352	13,195	13,802	15,051	15,829	16,824
ALL NONMANUFACTURING	194	234	276	313	384	497	559	603
ALL BUSINESS	10,908	11,465	12,628	13,514	14,186	15,548	16,388	17,427

Table V (Continued)

Industry	1969	1970	1971	1972	1973	1974	1975	1976
Iron & Steel	136	149	144	147	163	181	215	256
Nonferrous Metals	121	126	128	130	145	177	228	250
Non-Electrical Machinery	1,546	1,729	1,860	2,158	2,549	2,985	3,196	3,487
Electrical Machinery	4,347	4,220	4,389	4,680	4,902	5,011	5,105	5,636
Aerospace	5,878	5,219	4,881	4,950	5,052	5,278	5,713	6,339
Autos, Trucks & Parts	1,568	1,591	1,768	2,010	2,477	2,476	2,430	2,872
Fabricated Metals	192	207	242	253	291	313	324	358
Instruments	742	744	746	838	961	1,075	1,173	1,331
Stone, Clay & Glass	159	167	164	183	199	217	233	263
Lumber & Furniture	18	52	53	64	71	84	88	107
Chemicals	1,660	1,773	1,832	1,932	2,116	2,450	2,727	3,017
Paper & Pulp	188	178	187	189	194	237	249	313
Rubber & Plastic	261	276	289	377	426	469	467	502
Petroleum	467	515	505	468	498	622	693	767
Textiles	60	58	59	61	64	69	70	82
Food & Beverage	199	230	240	259	269	298	335	355
Other Manufacturing	121	128	131	146	158	177	205	217
ALL MANUFACTURING	17,653	17,362	17,618	18,845	20,535	22,119	23,451	26,152
ALL NONMANUFACUTURING	655	705	704	707	715	768	735	845
ALL BUSINESS	18,308	18,067	18,322	19,552	21,250	22,887	24,186	26,997

Industry	1977	1978	1979	1980	1981	1982	1983	1984	1985
Iron & Steel	284	314	375	443	487	600	669	625	605
Nonferrous Metals	254	246	259	285	391	400	446	476	585
Non-Electrical Machinery	3,880	4,283	4,825	5,901	6,818	7,835	8,186	9,668	10,870
Electrical Machinery	5,886	6,507	7,824	9,175	10,329	11,642	12,350	15,184	17,381
Aerospace	7,033	7,536	8,041	9,198	11,368	13,658	13,853	16,033	17,466
Autos, Trucks & Parts	3,478	4,010	4,668	5,117	4,986	4,962	5,631	6,090	7,058
Fabricated Metals	386	384	455	550	624	568	604	716	697
Instruments	1,572	1,998	2,505	3,029	3,514	4,013	4,144	4,891	5,420
Stone, Clay & Glass	287	324	356	406	467	460	500	564	587
Lumber & Furniture	123	126	139	148	161	162	169	181	172
Chemicals	3,202	3,580	4,038	4,636	5,625	6,659	7,293	8,023	8,674
Paper & Pulp	333	387	445	495	566	626	674	788	860
Rubber & Plastic	491	493	577	656	678	888	990	1,128	1,137
Petroleum	913	1,060	1,262	1,552	1,958	2,082	2,135	2,216	2,185
Textiles	93	89	101	115	130	129	130	144	158
Food & Beverage	415	472	523	620	641	761	765	839	820
Other Manufacturing	250	280	288	364	461	540	575	812	923
ALL MANUFACTURING	28,875	32,089	36,686	42,690	49,304	55,991	61,214	68,438	75,350
ALL NONMANUFACTURING	958	1,229	1,540	1,815	1,906	2,005	2,139	2,578	2,867
ALL BUSINESS	29,833	33,318	38,226	44,505	51,810	57,996	63,403	71,016	78,217

Table VI
Historical Research and Development Expenditures as a Percent of Capital Spending

Industry	1953	1954	1955	1956	1957	1958	1959	1960
Iron & Steel	4.5	7.4	6.9	5.4	4.7	8.0	10.3	7.6
Nonferrous Metals	4.7	9.7	12.4	8.0	5.0	10.7	19.7	23.8
Non-Electrical Machinery	42.0	51.9	56.2	50.4	52.1	84.4	91.4	78.4
Electrical Machinery	152.7	178.1	190.0	207.0	242.1	242.4	328.0	248.2
Aerospace	552.7	689.0	564.8	574.0	556.5	931.8	1,021.5	1,018.6
Autos, Trucks & Parts	37.6	30.6	38.0	33.0	48.0	79.4	69.1	59.9
Fabricated Metals	11.7	12.1	12.6	18.2	19.6	30.7	22.1	24.1
Instruments	NA	NA	NA	NA	NA	256.5	213.1	202.6
Stone, Clay & Glass	9.9	10.2	7.2	6.6	8.9	13.7	11.5	11.2
Chemicals	26.6	36.5	44.3	44.3	41.0	60.1	76.0	61.7
Paper & Pulp	7.1	7.3	6.2	4.5	4.3	7.3	7.6	7.3
Rubber & Plastic	22.3	32.1	33.3	32.1	32.2	40.0	41.4	35.1
Petroleum	5.2	5.7	5.6	5.3	5.5	9.0	10.0	10.2
Textiles	3.1	4.4	4.0	3.2	4.8	12.0	10.0	9.4
Food & Beverage	6.3	6.0	7.2	5.6	6.1	7.5	7.5	7.7
ALL MANUFACTURING	28.4	33.1	36.2	39.6	43.2	63.7	68.9	63.2
ALL NONMANUFACTURING	0.5	0.6	0.6	0.6	0.7	0.6	0.6	0.7
ALL BUSINESS	12.1	14.1	15.0	17.4	19.1	24.8	26.8	26.6

Industry	1961	1962	1963	1964	1965	1966	1967	1968
Iron & Steel	11.4	12.7	12.0	8.1	8.1	8.1	7.1	6.7
Nonferrous Metals	26.8	21.8	16.6	14.2	11.9	9.3	9.7	10.4
Non-Electrical Machinery	80.8	72.3	77.1	63.1	47.5	41.9	43.8	51.0
Electrical Machinery	227.0	265.9	281.0	252.9	189.3	144.3	123.5	129.0
Aerospace	1,255.4	1,023.3	1,077.0	1,231.0	975.9	472.3	453.5	470.6
Autos, Trucks & Parts	68.1	68.8	59.9	47.6	41.0	42.9	47.5	56.2
Fabricated Metals	25.9	24.6	22.3	17.5	15.8	13.5	12.6	13.5
Instruments	166.2	174.0	148.0	172.3	173.6	152.4	138.2	166.9
Stone, Clay & Glass	12.6	13.2	14.2	13.4	13.0	10.4	14.7	15.9
Chemicals	68.7	74.2	71.8	61.1	48.1	42.0	48.9	56.6
Paper & Pulp	9.5	10.5	9.8	8.5	3.8	8.8	8.6	11.3
Rubber & Plastic	38.3	37.6	40.3	33.8	27.7	25.8	27.4	23.4
Petroleum	10.1	10.1	10.2	11.2	10.2	8.3	7.7	8.8
Textiles	8.5	7.1	6.9	5.4	4.8	5.3	7.4	8.9
Food & Beverage	8.3	8.3	8.7	8.2	8.4	7.8	8.9	8.3
ALL MANUFACTURING	69.0	70.1	71.5	62.2	54.3	48.0	49.1	52.0
ALL NONMANUFACTURING	0.9	0.9	1.0	1.1	1.1	1.3	1.4	1.4
ALL BUSINESS	28.5	28.1	28.9	26.4	23.8	22.1	22.5	22.8

Table VI (Continued)

Industry	1969	1970	1971	1972	1973	1974	1975	1976
Iron & Steel	7.5	9.2	11.4	13.7	13.0	9.2	7.0	8.2
Nonferrous Metals	11.4	10.7	12.6	13.4	11.9	10.0	13.3	17.7
Non-Electrical Machinery	42.6	45.7	59.0	66.8	64.5	58.2	65.8	64.3
Electrical Machinery	133.0	120.9	144.7	165.5	140.7	131.8	165.6	156.2
Aerospace	454.8	593.1	777.8	722.6	633.5	435.3	480.1	621.5
Autos, Trucks & Parts	52.4	52.2	73.1	66.9	64.7	57.6	72.9	79.7
Fabricated Metals	13.6	17.0	20.1	17.7	16.1	16.2	16.6	16.3
Instruments	191.1	170.8	190.0	174.6	149.8	130.8	147.7	170.1
Stone, Clay & Glass	14.3	15.8	17.5	13.7	12.6	13.1	14.0	13.8
Chemicals	55.1	52.5	56.0	57.2	50.8	39.6	38.3	40.9
Paper & Pulp	11.6	10.3	14.6	13.0	9.7	8.2	8.5	10.5
Rubber & Plastic	24.3	30.1	36.5	36.6	27.3	29.1	38.9	36.6
Petroleum	8.9	10.0	9.7	9.3	10.8	8.8	7.6	7.7
Textiles	7.0	7.3	6.6	5.7	6.3	6.5	8.2	8.4
Food & Beverage	7.2	6.9	7.2	7.9	7.2	7.0	7.6	6.6
ALL MANUFACTURING	48.7	46.9	52.4	53.2	48.5	42.1	43.7	44.7
ALL NONMANUFACUTURING	1.3	1.3	1.2	1.0	0.9	0.9	0.8	0.8
ALL BUSINESS	21.4	19.7	19.7	18.9	17.7	16.4	17.0	17.0

Industry	1977	1978	1979	1980	1981	1982	1983	1984	1985
Iron & Steel	9.9	12.1	11.7	12.9	14.0	15.9	20.6	17.6	14.7
Nonferrous Metals	19.6	16.9	15.7	13.4	15.5	21.1	25.7	22.4	31.2
Non-Electrical Machinery	61.1	57.7	47.5	51.7	49.8	58.3	62.1	62.7	68.0
Electrical Machinery	127.5	110.5	103.7	93.9	97.7	105.8	122.1	104.6	110.4
Aerospace	616.9	427.0	297.8	257.8	356.2	400.5	475.6	448.8	505.9
Autos, Trucks & Parts	59.8	55.8	56.0	56.7	50.7	63.8	77.3	54.4	48.2
Fabricated Metals	15.7	13.1	14.1	16.5	17.2	18.4	21.5	20.9	19.5
Instruments	167.4	181.7	176.5	181.1	178.5	191.1	246.3	211.1	210.0
Stone, Clay & Glass	12.5	10.3	8.9	10.2	13.7	15.8	18.0	18.2	17.3
Chemicals	43.5	46.1	41.2	39.9	42.9	52.6	56.3	52.4	52.7
Paper & Pulp	9.6	10.2	8.5	7.6	9.3	11.2	11.4	10.9	10.0
Rubber & Plastic	27.8	21.2	23.4	32.3	31.5	41.0	40.2	36.3	30.8
Petroleum	7.8	8.1	8.3	7.9	7.5	7.9	9.2	8.7	8.2
Textiles	7.0	6.8	7.1	7.5	7.8	8.8	9.4	7.5	8.9
Food & Beverage	7.3	7.2	7.3	7.6	6.8	8.7	9.8	9.5	7.9
ALL MANUFACTURING	42.8	40.8	38.2	38.0	39.4	46.4	52.7	49.3	49.1
ALL NONMANUFACUTURING	0.8	0.9	1.0	1.1	1.0	1.1	1.2	1.2	1.2
ALL BUSINESS	16.1	15.3	15.0	15.7	16.4	18.7	20.8	20.0	20.2

Table VII
Historical Research and Development Expenditures as a Percent of Sales

Industry	1953	1954	1955	1956	1957	1958	1959	1960
Iron & Steel	NA	NA	NA	NA	NA	0.5	0.5	0.6
Nonferrous Metals	NA	NA	NA	NA	NA	0.6	0.7	0.7
Non-Electrical Machinery	NA	NA	NA	NA	NA	3.3	3.5	3.5
Electrical Machinery	NA	NA	NA	NA	NA	10.4	10.5	10.8
Aerospace	NA	NA	NA	NA	NA	16.9	19.5	23.6
Autos, Trucks & Parts	NA	NA	NA	NA	NA	4.2	3.3	3.0
Fabricated Metals	NA	NA	NA	NA	NA	0.8	0.6	0.6
Instruments	NA	NA	NA	NA	NA	5.1	4.7	4.8
Stone, Clay & Glass	NA	NA	NA	NA	NA	0.8	0.7	0.8
Chemicals	NA	NA	NA	NA	NA	3.5	3.4	3.8
Paper & Pulp	NA	NA	NA	NA	NA	0.3	0.3	0.4
Rubber & Plastic	NA	NA	NA	NA	NA	1.3	1.4	1.5
Petroleum	NA	NA	NA	NA	NA	1.6	1.7	1.8
Textiles	NA	NA	NA	NA	NA	0.2	0.2	0.3
Food & Beverage	NA	NA	NA	NA	NA	0.1	0.1	0.2
ALL MANUFACTURING	NA	NA	NA	NA	NA	2.5	2.6	2.8

Industry	1961	1962	1963	1964	1965	1966	1967	1968
Iron & Steel	0.6	0.5	0.6	0.5	0.5	0.6	0.6	0.5
Nonferrous Metals	0.7	0.6	0.6	0.6	0.5	0.5	0.6	0.6
Non-Electrical Machinery	3.4	3.1	3.1	2.9	2.7	2.6	2.7	2.7
Electrical Machinery	9.9	9.4	9.8	9.9	9.3	9.1	9.2	9.0
Aerospace	24.5	24.9	27.9	30.3	29.4	26.0	22.1	20.8
Autos, Trucks & Parts	3.7	3.1	3.1	3.2	2.7	3.0	3.3	3.0
Fabricated Metals	0.6	0.6	0.6	0.5	0.4	0.4	0.4	0.4
Instruments	4.4	4.5	4.1	4.5	4.7	4.7	4.9	5.4
Stone, Clay & Glass	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9
Chemicals	4.1	4.1	4.0	3.8	3.7	3.5	3.6	3.5
Paper & Pulp	0.4	0.4	0.4	0.4	0.5	0.6	0.6	0.6
Rubber & Plastic	1.7	1.6	1.6	1.5	1.4	1.3	1.4	1.5
Petroleum	1.8	1.8	1.8	2.1	2.1	1.8	1.7	1.9
Textiles	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
Food & Beverage	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
ALL MANUFACTURING	2.9	2.8	2.9	2.9	2.8	2.8	2.8	2.8

Table VII (Continued)

Industry	1969	1970	1971	1972	1973	1974	1975	1976
Iron & Steel	0.5	0.6	0.6	0.5	0.4	0.4	0.5	0.5
Nonferrous Metals	0.5	0.6	0.6	0.5	0.5	0.5	0.8	0.7
Non-Electrical Machinery	2.8	3.1	3.3	3.3	3.3	3.2	3.3	3.3
Electrical Machinery	9.1	9.0	9.1	8.8	8.0	7.6	8.0	7.6
Aerospace	21.9	21.3	21.8	23.5	20.2	19.4	19.7	20.8
Autos, Trucks & Parts	3.1	3.7	3.0	3.2	3.3	3.6	3.5	3.0
Fabricated Metals	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Instruments	5.7	5.7	5.5	5.4	5.4	5.1	5.3	5.3
Stone, Clay & Glass	0.9	1.0	0.9	0.8	0.8	0.8	0.9	0.9
Chemicals	3.5	3.7	3.6	3.4	3.3	2.9	3.0	2.9
Paper & Pulp	0.8	0.7	0.7	0.7	0.6	0.6	0.6	0.6
Rubber & Plastic	1.6	1.7	1.6	1.8	1.7	1.7	1.7	1.6
Petroleum	1.9	2.1	1.9	1.6	1.4	1.1	1.0	0.9
Textiles	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2
Food & Beverage	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
ALL MANUFACTURING	2.7	2.7	2.6	2.5	2.3	2.2	2.3	2.2

Industry	1977	1978	1979	1980	1981	1982	1983	1984	1985
Iron & Steel	0.6	0.5	0.6	0.7	0.7	1.3	1.4	1.2	1.3
Nonferrous Metals	0.6	0.5	0.5	0.5	0.7	0.8	0.8	0.8	1.1
Non-Electrical Machinery	3.2	3.0	2.9	3.3	3.4	4.2	4.7	4.6	5.1
Electrical Machinery	6.7	6.5	6.7	7.1	7.4	7.9	8.8	8.2	8.9
Aerospace	21.7	20.2	16.6	15.8	18.5	20.6	18.5	20.4	19.2
Autos, Trucks & Parts	3.0	3.0	3.6	4.9	4.3	4.4	3.8	3.4	3.7
Fabricated Metals	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5
Instruments	5.4	5.9	6.6	6.9	7.5	7.8	8.3	8.2	8.9
Stone, Clay & Glass	0.8	0.8	0.8	0.9	1.0	1.0	1.0	1.1	1.1
Chemicals	2.7	2.8	2.7	2.9	3.1	3.9	4.0	4.0	4.4
Paper & Pulp	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.9
Rubber & Plastic	1.2	1.1	1.2	1.4	1.3	1.6	1.6	1.6	1.7
Petroleum	0.9	1.0	0.9	0.8	0.9	1.0	1.1	1.2	1.2
Textiles	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.3	0.3
Food & Beverage	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3
ALL MANUFACTURING	2.1	2.1	2.1	2.3	2.5	2.9	3.0	3.0	3.3

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33rd ANNUAL DRI/McGRAW-HILL SURVEY OF RESEARCH AND DEVELOPMENT EXPENDITURES, 1988-90

Research and development (R&D) spending by U.S. corporations may be improving from its weak performance of the past few years, but the pace of the increase leaves much room for doubt in American industry's will to reclaim its competitive edge. According to the latest DRI/McGraw-Hill survey, nominal R&D investment by U.S. business is projected to rise 6.5% in 1988, to $88.3 billion, and another 10.8% from 1988 to 1990 (Table I*).

Chart 1
Research and Development Spending by All Businesses
(Billions of dollars)

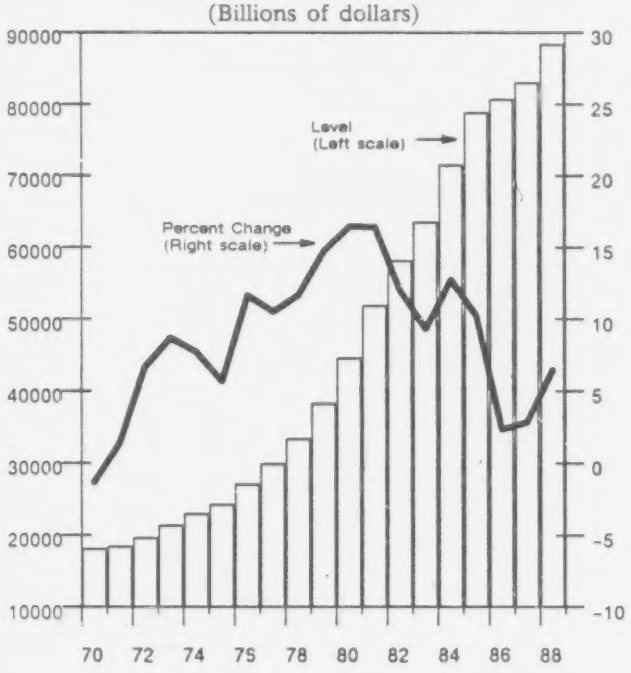
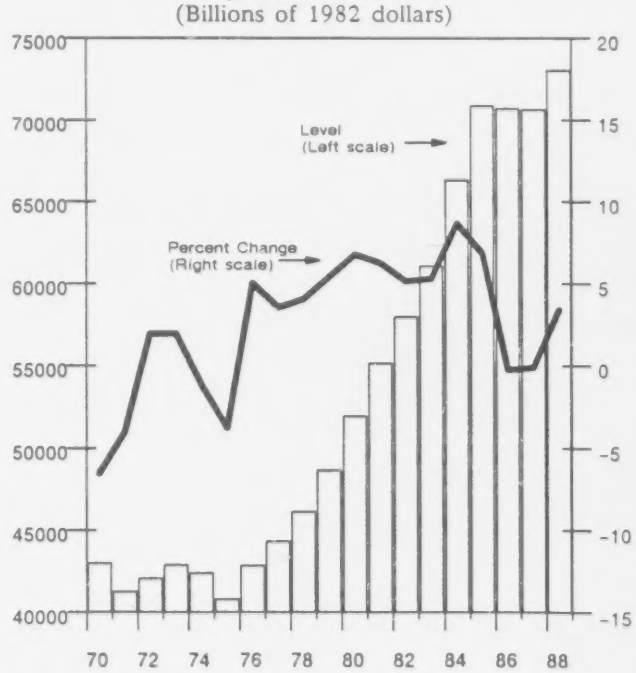


Chart 2
Real Research and Development Spending by All Businesses
(Billions of 1982 dollars)



* Tables denoted by Roman numerals appear at the end of this report.

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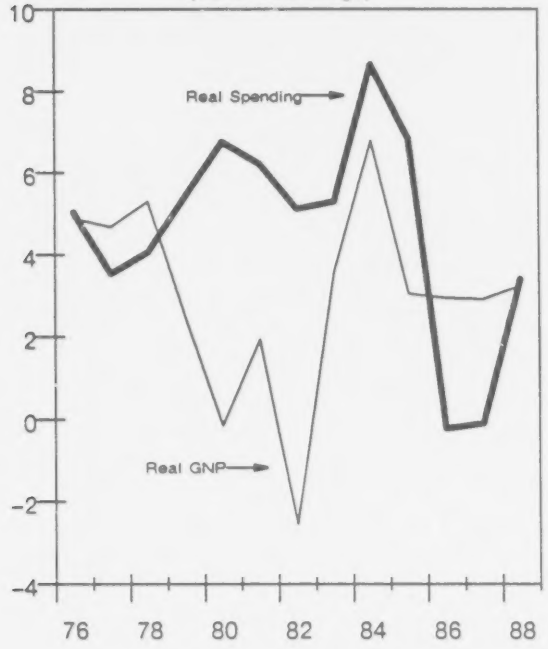
Chart 3
Growth in Real Research and Development Spending
and Real Gross National Product
(Percent change)



Still, with inflation creeping up, the 6.5% nominal gain is not that impressive: adjusted for inflation, real R&D spending by American industries in 1988 should rise only 3.4% above last year's level. In addition, the real advance barely surpasses DRI's estimate of real GNP growth for the current year. Consequently, although R&D spending is no longer slipping below the nation's rate of economic growth, little lost ground is being recovered.

These are the key findings of the 33rd Annual DRI/McGraw-Hill Survey of Research and Development Expenditures, 1988-90. Conducted in April and May, the survey drew responses from 366 companies replying to a broader questionnaire of capital spending plans. All dollar figures in this report have been adjusted to represent R&D spending by all U.S. companies and reflect domestic investment only. In addition, this report includes noncontract federal funds spent by private business.

THE PESSIMISTIC VIEW OF SPENDING (EXCLUDING FUNHOUSE MIRRORS)

R&D spending is beginning to emerge from a very disappointing two years: after advancing 10.2% in 1985, nominal R&D investment rose a paltry 2.4% in 1986 and another 2.9% in 1987. In fact, R&D spending averaged vigorous 12.6% annual increases in the decade prior to 1986 (Table V). In constant-dollar terms, R&D spending fared even more poorly. After average annual increases of 5.7% from 1976 to

Chart 4
Growth in Research and Development Spending
(Percent change)

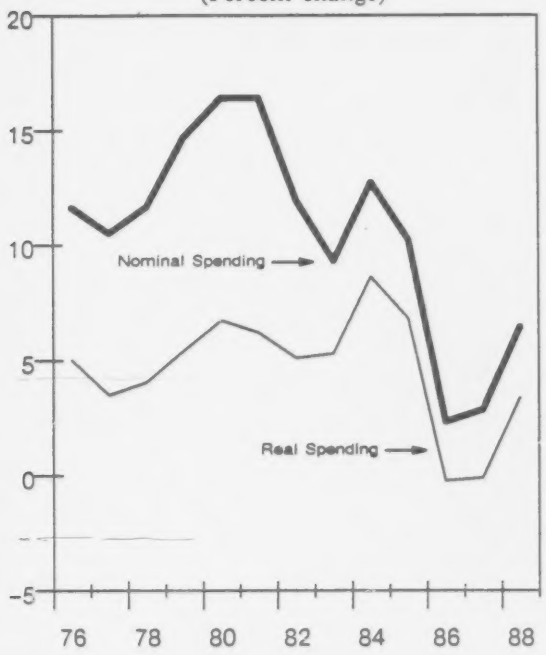
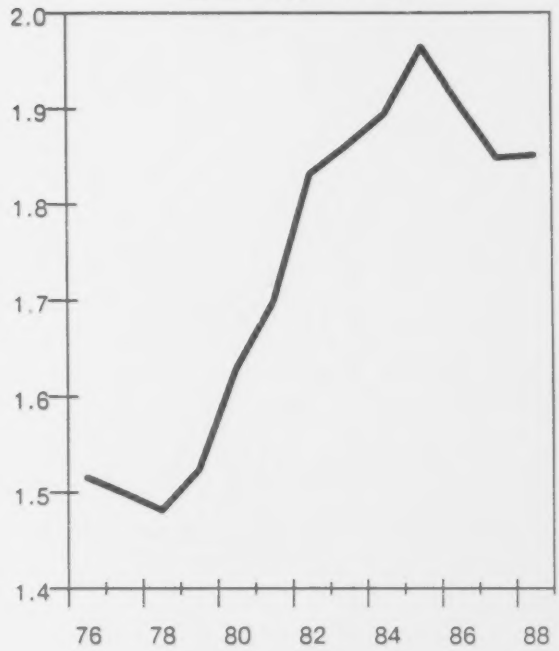


Chart 5
Research and Development Spending
as a Percent of GNP



1985, real R&D investment fell 0.2% in both 1986 and 1987. Even a small turnaround this year is cause for encouragement.

As a share of GNP, R&D spending peaked in 1985 at 1.96% before slipping to 1.85% in 1987. (In 1976, the share stood at 1.52%.) If both R&D and GNP growth projections for 1988 prove true, the ratio should hold steady at 1.85%. In the face of a highly competitive global economy, U.S business has yet to push ahead in innovation.

After a buffeting by an abnormally strong dollar in the early and mid-1980s, U.S. companies benefited from the 37% depreciation since early 1985, gaining an edge over foreign competitors. Real exports increased 12.8% last year, as exporting firms took full advantage of their position to increase market share through limited price hikes. For many reasons, however, the U.S cannot hope to compete internationally using this practice alone.

While no one primary reason for the slump in R&D seems to exist, short-term profitability strategies appear to be guiding U.S. corporate planning. In light of the extreme volatility of recent years, highlighted by the rash of mergers, restructurings, and takeovers, businesses have grown more cautious in their long-term plans. Persistently high real interest rates also encourage policies geared to short-term profits.

Moreover, tax reform lowered the R&D tax credit from 25% to 20% and threatens to eliminate it altogether at the close of 1988. (DRI expects the credit to survive in some form.)

THE OPTIMISTIC VIEW (WITH THE MIRRORS)

When compared with sales measures, manufacturers' research and development budgets appear less troubled. After hovering near 2.8–2.9% of sales during the 1960s, R&D investment was reined in sharply after the mid–1970s, running at a record low of 2.1% of sales between 1977 and 1979 (Table VII). By 1983, however, it reached a record high of 3.0% and climbed to 3.4% by the end of 1986. After dropping to 3.3% last year, R&D as a share of sales is expected to slip to 3.2% in 1988--a disturbing downward trend, but still high by historical standards (Table IV).

The trend is similar when comparing R&D investment with capital spending: after breaking the 20% barrier in 1983, R&D as a percent of total investment rose to 21.3% by 1987 (Table VI). While the latest survey indicates a drop to 20.7% this year, this is largely the result of the strong 9.9% capital spending increase slated for 1988 (Table III). Capital spending has been fairly weak during the last two years, allowing R&D (which is not an investment subset) a more favorable comparison in 1986 and 1987.

Chart 6
Research and Development Spending by All Manufacturing Industries as a Percent of Sales

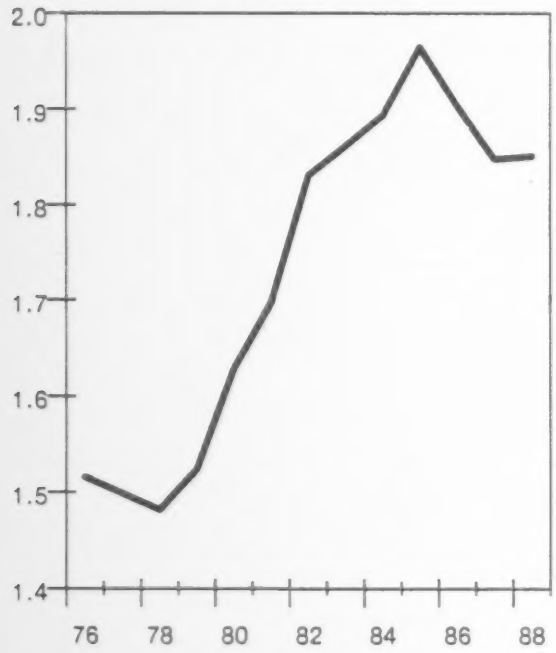
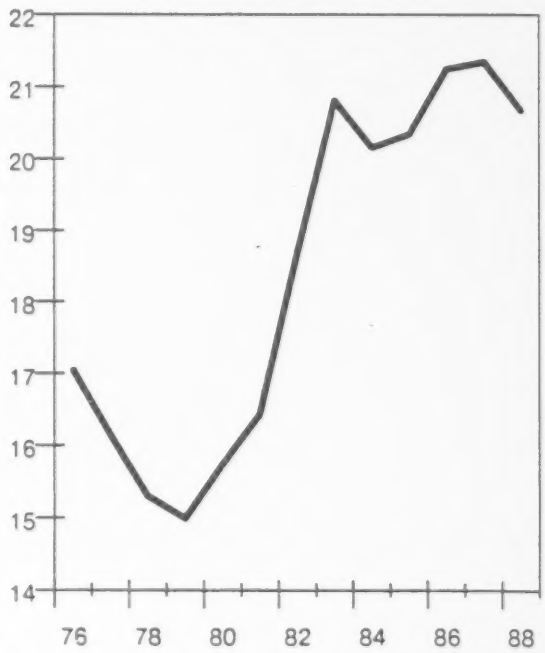


Chart 7
Research and Development Spending by All Businesses as a Percent of Capital Spending



R&D SPENDING BY SECTOR

The aerospace industry has led all manufacturers in research and development outlays, aided greatly by heavy funding from the Pentagon for weapons systems. This large chunk of dollars does little, however, to directly enhance the nation's economic competitiveness. Defense budget cuts by Congress do diminish the aerospace industry's total R&D effort, even excluding contract R&D, because the Competition in Contracting Act of 1984 forced defense contractors to put up more of their own money to fund defense aerospace projects. After falling 9.4% in 1986, aerospace R&D rose 3.1% last year. Survey respondents indicated a 6.1% increase for 1988 and plan to boost spending 19% above this year's level by 1990.

The electrical equipment industry, the other dominant R&D player, is coming off a tough year, when R&D spending fell 5.8%. In 1988, electrical machinery makers plan a modest comeback of 3.5%, with all product groups predicting increases. Manufacturers of electronic components expect their now-typical double-digit increase. Electrical industrial apparatus manufacturers plan a 5% rise in R&D spending this year, while the household appliance and electrical distribution equipment industries both foresee 4% increases (Table II).

Following their relatively strong 7.6% R&D advance last year, nonelectrical machinery makers plan a 14.6% surge in 1988, with strength from all product industries except farm equipment. After an unexpectedly strong 20.6% increase in 1987, computer companies plan another double-digit rise of 17.2% in 1988. After an 8.8% cutback in 1987, general industrial machinery manufacturers plan an 8.2% spending rebound this year. Makers of construction, mining, and materials handling equipment report a 7.5% rise in their 1988 R&D budgets.

Elsewhere within manufacturing, the chemical industry plans an 8.2% rise in R&D spending in 1988, following a healthy 11.7% gain last year. The automotive industry increased research and development budgets a slight 1.6% last year and predicts another slim gain of 2.5% in 1988, resulting in two years of decline for real R&D spending. Instrument makers expect a 4.4% increase in the current year, while the petroleum industry plans a 6.5% spending hike in 1988 after a slight cut in 1987.

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Table I
Research and Development Expenditures
(Millions of dollars)

Industry	1986 Actual	1987 Estimated	Planned		Percent Change	
			1988	1990	1987-88	1988-90
Iron & Steel	718	683	734	796	7.5	8.5
Nonferrous Metals	461	483	469	432	-2.8	-7.9
Electrical Equipment	17,591	16,574	17,148	18,281	3.5	6.6
Machinery	10,696	11,514	13,193	15,053	14.6	14.1
Motor Vehicles	10,050	10,209	10,463	11,509	2.5	10.0
Aerospace	16,240	16,737	17,759	21,111	6.1	18.9
Fabricated Metal Products	622	666	727	792	9.3	8.9
Instruments	5,421	5,838	6,097	6,364	4.4	4.4
Stone, Clay & Glass	546	531	584	613	9.9	5.0
Lumber & Furniture	176	166	175	192	5.3	9.9
Chemicals	9,021	10,077	10,901	12,066	8.2	10.7
Paper	894	1,029	1,077	1,164	4.6	8.1
Rubber	1,075	998	1,073	1,106	7.6	3.1
Petroleum	2,069	2,009	2,140	2,167	6.5	1.3
Food	1,083	1,143	1,193	1,261	4.3	5.7
Textiles & Apparel	157	171	175	179	2.1	2.2
Other Manufacturing	655	770	798	899	3.6	12.6
ALL MANUFACTURING	77,475	79,600	84,705	93,985	6.4	11.0
ALL NONMANUFACTURING	3,154	3,350	3,598	3,880	7.4	7.8
ALL BUSINESS	80,629	82,949	88,302	97,865	6.5	10.8

Table II
Detailed Industry Data

	Research & Development Percent Change		
	1986-87	1987-88	1988-90
Durables			
Iron & Steel	-4.9	7.5	8.5
Nonferrous Metals	4.7	-2.8	-7.9
Primary Nonferrous Metals	8.3	-0.3	-10.0
Electrical Machinery	-5.8	3.5	6.6
Electric Distributing Equipment	-9.6	4.0	4.0
Electrical Industrial Apparatus	-13.3	5.0	15.0
Household Appliances	5.3	4.0	4.0
Communication Equipment	5.1	0.8	5.0
Electronic Components	16.9	12.5	22.9
Misc. Electrical	43.7	9.6	-0.8
Non-Electrical Machinery	7.7	14.6	14.1
Farm Equipment	7.8	-8.8	17.6
Construction, Mining, Materials Handling Eq.	15.1	7.5	6.6
Metalworking Machinery	-41.3	3.2	5.3
Special Industry Machinery	-16.8	1.1	2.4
General Industrial Machinery	-8.8	8.2	9.0
Office, Computing Machinery	20.6	17.2	14.5
Refrigeration and Service Industry Machinery	-14.7	2.0	3.0
Autos, Trucks & Parts	1.6	2.5	10.0
Aerospace	-10.4	14.0	1.8
Fabricated Metals	7.0	9.3	8.9
Cutlery, Hand Tools, Hardware	16.0	15.0	15.0
Plumbing and Heating Eq	0.0	0.0	20.0
Fabricated Structural Metal	27.3	9.3	9.7
Screw Machine Products	8.2	10.0	5.0
Metal Forgings and Stampings	-50.0	0.0	0.0
Misc. Fabricated Metals	1.4	5.2	5.9
Instruments	7.7	4.4	4.4
Engineering & Scientific Instruments	-0.5	28.8	14.6
Measuring and Controlling Devices	4.3	-0.4	1.2
Optical Instruments and Lenses	400.0	20.0	20.0
Medical Instruments and Supplies	23.3	12.7	11.1
Stone, Clay & Glass	-2.7	9.9	5.0
Glass and Glassware, Pressed or Blown	-16.0	3.0	2.0
Products of Purchased Glass	11.4	15.0	6.0
Cement, Hydraulic	-3.6	4.4	4.4
Structural Clay Products	-5.9	9.5	NA
Misc. Nonmetallic Mineral Products	-12.5	5.0	5.0
Other Durables	111.3	7.2	10.0
Lumber	NA	5.0	10.0
Furniture	-7.4	23.4	0.0

Table II
(Continued)

	Research & Development Percent Change		
	1986-87	1987-88	1988-90
Nondurables			
Chemicals	11.7	8.2	10.7
Industrial Inorganic Chemicals	-0.3	7.9	16.0
Plastics Materials and Synthetics	2.3	2.0	-3.0
Drugs	13.8	14.5	12.5
Soap, Cleaners, & Toilet Goods	2.2	10.7	9.5
Paints	2.9	4.0	3.6
Agricultural Chemicals	75.4	9.9	5.1
Misc. Chemicals	4.8	9.5	7.0
Paper & Pulp	14.5	4.6	8.1
Paper Mills	16.9	5.2	5.6
Converted Paper Prod	6.7	5.0	5.0
Rubber & Plastic	-9.8	7.6	3.1
Petroleum	-2.9	6.5	1.3
Food & Beverage	5.6	4.3	5.7
Dairy Products	20.2	5.0	8.5
Preserved Fruits and Vegetables	100.9	-9.0	4.0
Grain Mill Products	9.4	5.0	5.0
Beverages	-55.3	4.0	6.0
Textiles	9.1	2.1	2.2
Weaving Mills, Cotton	8.7	2.0	2.0
Knitting Mills	20.0	5.0	7.0
Other Nondurables	14.1	9.2	12.8
Tobacco	8.8	0.0	10.0
Apparel	0.0	5.0	10.0
Printing and Publishing	25.0	8.9	17.8
Nonmanufacturing			
Mining	-12.5	0.1	3.8
Metal Mining	2.2	0.0	5.0
Oil & Gas Extraction	-40.0	0.0	0.0
Stone & Earth Minerals	0.0	10.0	10.0

Table III
Research and Development as a Percent of Capital Spending

Industry	1987	1988
Iron & Steel	14.8	12.3
Nonferrous Metals	22.6	18.6
Electrical Equipment	108.6	99.4
Machinery	83.6	88.7
Autos, Trucks & Parts	84.9	93.0
Aerospace	471.8	429.2
Fabricated Metal Products	16.6	16.5
Instruments	248.3	205.8
Stone, Clay & Glass	15.8	17.4
Chemicals	61.6	55.7
Paper	11.5	9.2
Ruboer	28.4	28.7
Petroleum	11.9	11.1
Food	10.4	9.1
Textiles	8.8	8.5
Other Manufacturing	3.7	3.4
ALL MANUFACTURING	54.7	51.4
ALL NONMANUFACTURING	1.4	1.4
ALL BUSINESS	21.3	20.7

Table IV
Research and Development as a Percent of Sales

Industry	1987	1988
Iron & Steel	1.4	1.5
Nonferrous Metals	0.9	0.8
Electrical Equipment	7.4	7.1
Machinery	5.4	5.6
Autos, Trucks & Parts	5.1	NA
Aerospace	16.6	16.0
Fabricated Metal Products	0.5	0.5
Instruments	9.2	8.7
Stone, Clay & Glass	0.9	0.8
Chemicals	4.7	4.7
Paper	0.9	0.8
Rubber	1.3	1.3
Petroleum	1.5	1.6
Food	0.3	0.3
Textiles	0.3	0.3
Other Manufacturing	0.2	NA
ALL MANUFACTURING	3.3	3.2

Table V
Historical Research and Development Expenditures
(Millions of dollars)

Industry	1953	1954	1955	1956	1957	1958	1959	1960
Iron & Steel.....	42	44	46	55	64	80	84	102
Nonferrous Metals.....	20	25	28	35	44	51	68	75
Non-Electrical Machinery	330	358	455	543	669	781	930	949
Electrical Machinery....	817	904	983	1,516	1,804	1,969	2,329	2,532
Aerospace.....	829	999	1,285	2,138	2,574	2,609	3,090	3,514
Autos, Trucks & Parts...	495	531	561	688	707	856	866	884
Fabricated Metals.....	52	55	65	116	135	162	138	145
Instruments.....	178	195	176	200	249	294	309	329
Stone, Clay & Glass.....	40	45	46	60	69	75	81	88
Lumber & Furniture.....	10	10	10	10	14	12	12	10
Chemicals.....	374	407	445	641	705	792	891	980
Paper & Pulp.....	29	33	32	36	35	42	49	56
Rubber & Plastic.....	54	65	79	105	107	89	115	121
Petroleum.....	149	167	172	182	211	246	278	296
Textiles.....	10	12	12	12	15	26	30	38
Food & Beverage.....	54	61	70	64	74	83	91	104
Other Manufacturing.....	53	58	64	74	93	105	118	119
ALL MANUFACTURING.....	3,536	3,969	4,529	6,475	7,569	8,272	9,479	10,342
ALL NONMANUFACUTURING...	94	101	111	130	162	117	139	168
ALL BUSINESS.....	3,630	4,070	4,640	6,605	7,731	8,389	9,618	10,510

Industry	1961	1962	1963	1964	1965	1966	1967	1968
Iron & Steel.....	98	97	106	116	128	139	135	135
Nonferrous Metals.....	79	74	77	79	85	93	107	115
Non-Electrical Machinery	901	914	958	1,015	1,065	1,217	1,326	1,483
Electrical Machinery....	2,483	2,639	2,866	2,972	3,200	3,626	3,867	4,083
Aerospace.....	3,829	4,042	4,712	5,078	5,148	5,526	5,669	5,765
Autos, Trucks & Parts...	936	999	1,090	1,182	1,230	1,344	1,354	1,499
Fabricated Metals.....	136	146	153	148	145	154	163	183
Instruments.....	297	309	284	331	403	468	542	663
Stone, Clay & Glass.....	88	96	100	109	112	117	136	142
Lumber & Furniture.....	10	10	11	12	11	12	12	20
Chemicals.....	1,101	1,175	1,239	1,284	1,356	1,407	1,507	1,589
Paper & Pulp.....	59	65	69	77	94	117	128	144
Rubber & Plastic.....	138	141	156	158	162	168	182	223
Petroleum.....	299	310	317	393	397	371	371	437
Textiles.....	30	28	30	32	38	51	57	58
Food & Beverage.....	125	121	130	144	157	164	183	184
Other Manufacturing.....	105	65	54	65	71	77	90	101
ALL MANUFACTURING.....	10,714	11,231	12,352	13,195	13,802	15,051	15,829	16,824
ALL NONMANUFACUTURING...	194	234	276	319	384	497	559	603
ALL BUSINESS.....	10,908	11,465	12,628	13,514	14,186	15,548	16,388	17,427

Table V
(Continued)

Industry	1969	1970	1971	1972	1973	1974	1975	1976	1977
Iron & Steel	136	149	144	147	163	181	215	256	284
Nonferrous Metals	121	126	128	130	145	177	228	250	254
Machinery	1,546	1,729	1,860	2,158	2,549	2,985	3,196	3,487	3,880
Electrical Equipment	4,347	4,220	4,389	4,680	4,902	5,011	5,105	5,636	5,886
Aerospace	5,878	5,219	4,881	4,950	5,052	5,278	5,713	6,339	7,033
Autos, Trucks & Parts	1,568	1,591	1,768	2,010	2,477	2,476	2,430	2,872	3,478
Fabricated Metal Products	182	207	242	253	291	313	324	358	386
Instruments	742	744	746	838	961	1,075	1,173	1,331	1,572
Stone, Clay & Glass	159	167	164	183	199	217	233	263	287
Lumber & Furniture	18	52	53	64	71	84	88	107	123
Chemicals	1,660	1,773	1,832	1,932	2,116	2,450	2,727	3,017	3,202
Paper	188	178	187	189	194	237	249	313	333
Rubber	261	276	289	377	426	469	467	502	491
Petroleum	467	515	505	468	498	622	693	767	918
Textiles	60	58	59	61	64	69	70	82	83
Food	199	230	240	259	269	298	335	355	415
Other Manufacturing	121	128	131	146	158	177	205	217	250
ALL MANUFACTURING	17,653	17,362	17,618	18,845	20,535	22,119	23,451	26,152	28,875
ALL NONMANUFACTURING	655	705	704	707	715	768	735	845	958
ALL BUSINESS	18,308	18,067	18,322	19,552	21,250	22,887	24,186	26,997	29,833

Industry	1978	1979	1980	1981	1982	1983	1984	1985	1986
Iron & Steel	314	375	443	575	679	776	720	677	718
Nonferrous Metals	246	259	285	303	321	339	357	424	461
Machinery	4,283	4,825	5,901	6,818	7,835	8,386	9,667	10,853	10,696
Electrical Equipment	6,507	7,824	9,175	10,329	11,642	13,950	15,694	17,055	17,591
Aerospace	7,536	8,041	9,198	11,968	13,658	13,853	16,033	17,918	16,240
Autos, Trucks & Parts	4,010	4,668	5,117	4,806	4,807	5,337	6,090	7,035	10,050
Fabricated Metal Products	384	455	550	624	568	604	716	628	622
Instruments	1,998	2,505	3,029	3,614	4,019	4,444	4,840	5,303	5,421
Stone, Clay & Glass	324	356	406	460	463	504	532	545	546
Lumber & Furniture	126	139	148	161	162	169	181	172	176
Chemicals	3,580	4,038	4,636	5,625	6,659	7,293	8,028	8,690	9,021
Paper	387	445	495	560	626	693	760	827	894
Rubber	493	577	656	796	936	1,076	1,216	1,147	1,075
Petroleum	1,060	1,262	1,552	1,972	2,195	2,249	2,412	2,328	2,069
Textiles	89	101	115	116	124	125	139	152	157
Food	472	528	620	636	762	766	1,001	995	1,083
Other Manufacturing	280	288	364	541	535	650	499	605	655
ALL MANUFACTURING	32,089	36,686	42,690	49,904	55,991	61,214	68,885	75,354	77,475
ALL NONMANUFACTURING	1,229	1,540	1,815	1,906	2,005	2,189	2,585	3,422	3,154
ALL BUSINESS	33,318	38,226	44,505	51,810	57,996	63,403	71,470	78,776	80,629

Table VI
Historical Research and Development Expenditures as a Percent of Capital Spending

Industry	1953	1954	1955	1956	1957	1958	1959	1960
Iron & Steel	4.5	7.4	6.9	5.4	4.7	8.0	10.3	7.6
Nonferrous Metals	4.7	9.7	12.4	8.0	5.0	10.7	19.7	23.8
Non-Electrical Machinery	42.0	51.9	56.2	50.4	52.1	84.4	91.4	78.4
Electrical Machinery	152.7	178.1	190.0	207.0	242.1	342.4	328.0	248.2
Aerospace	552.7	689.0	564.8	574.0	556.5	931.8	1,021.5	1,018.6
Autos, Trucks & Parts	37.6	30.6	38.0	33.0	48.0	79.4	69.1	59.9
Fabricated Metals	11.7	12.1	12.6	18.2	19.6	30.7	22.1	24.1
Instruments	NA	NA	NA	NA	NA	256.5	213.1	202.6
Stone, Clay & Glass	9.9	10.2	7.2	6.6	8.9	13.7	11.5	11.2
Chemicals	26.6	36.5	44.3	44.3	41.0	60.1	76.0	61.7
Paper & Pulp	7.1	7.3	6.2	4.5	4.3	7.3	7.6	7.3
Rubber & Plastic	22.3	32.1	33.3	32.1	32.2	40.0	41.4	35.1
Petroleum	5.2	5.7	5.6	5.3	5.5	9.0	10.0	10.2
Textiles	3.1	4.4	4.0	3.2	4.8	12.0	10.0	9.4
Food & Beverage	5.3	6.0	7.2	5.6	6.1	7.5	7.5	7.7
ALL MANUFACTURING	28.4	33.1	36.2	39.6	43.2	63.7	68.9	63.2
ALL NONMANUFACUTURING	0.5	0.6	0.6	0.6	0.7	0.6	0.6	0.7
ALL BUSINESS	12.1	14.1	15.0	17.4	19.1	24.8	26.8	26.6

Industry	1961	1962	1963	1964	1965	1966	1967	1968
Iron & Steel	11.4	12.7	12.0	8.1	8.1	8.1	7.1	6.7
Nonferrous Metals	26.8	21.8	16.6	14.2	11.9	9.3	9.7	10.4
Non-Electrical Machinery	80.8	72.3	77.1	63.1	47.5	41.9	43.8	51.0
Electrical Machinery	237.0	265.9	281.0	252.9	189.3	144.3	123.5	129.0
Aerospace	1,255.4	1,023.3	1,077.0	1,231.0	975.9	472.3	453.5	470.6
Autos, Trucks & Parts	68.1	68.8	59.9	47.6	41.0	42.9	47.5	56.2
Fabricated Metals	25.9	24.6	22.3	17.5	16.8	13.5	12.6	13.5
Instruments	166.2	174.0	148.0	172.3	173.6	152.4	138.2	166.9
Stone, Clay & Glass	12.6	13.2	14.2	13.4	13.0	10.4	14.7	15.9
Chemicals	68.7	74.2	71.8	61.1	48.1	42.0	48.9	56.6
Paper & Pulp	9.5	10.5	9.8	8.5	8.8	8.8	8.6	11.3
Rubber & Plastic	38.3	37.6	40.3	33.8	27.7	25.8	27.4	23.4
Petroleum	10.1	10.1	10.2	11.2	10.2	8.3	7.7	8.8
Textiles	8.5	7.1	6.9	5.4	4.8	5.3	7.4	8.9
Food & Beverage	8.3	8.3	8.7	8.2	8.4	7.8	8.9	8.3
ALL MANUFACTURING	69.0	70.1	71.5	62.2	54.3	48.0	49.1	52.0
ALL NONMANUFACUTURING	0.9	0.9	1.0	1.1	1.1	1.3	1.4	1.4
ALL BUSINESS	28.5	28.1	28.9	26.4	23.8	22.1	22.5	22.8

Table VI
(Continued)

Industry	1969	1970	1971	1972	1973	1974	1975	1976	1977
Iron & Steel	7.5	9.2	11.4	13.7	13.0	9.2	7.0	8.2	9.9
Nonferrous Metals	11.4	10.7	12.6	13.4	11.9	10.0	13.3	17.7	19.6
Machinery	42.6	45.7	59.0	66.8	64.5	58.2	65.8	64.3	61.1
Electrical Equipment	133.0	120.9	144.7	165.5	140.7	131.8	165.6	156.2	127.5
Aerospace	454.8	593.1	777.8	722.6	633.5	435.3	480.1	621.5	616.9
Autos, Trucks & Parts	52.4	52.2	73.1	66.9	64.7	57.6	72.9	79.7	59.8
Fabricated Metal Products	13.6	17.0	20.1	17.7	16.1	16.2	16.6	16.3	15.7
Instruments	191.1	170.8	190.0	174.6	149.8	130.8	147.7	170.1	167.4
Stone, Clay & Glass	14.3	15.8	17.5	13.7	12.6	13.1	14.0	13.8	12.5
Chemicals	55.1	52.5	56.0	57.2	50.8	39.6	36.3	40.9	43.5
Paper	11.6	10.3	14.6	13.0	9.7	8.2	8.5	10.5	9.6
Rubber	24.3	30.1	36.5	36.6	27.3	29.1	38.9	36.6	27.8
Petroleum	8.9	10.0	9.7	9.8	10.8	8.8	7.6	7.7	7.8
Textiles	7.0	7.3	6.6	5.7	6.3	6.5	8.2	8.4	7.0
Food	7.2	6.9	7.2	7.9	7.2	7.0	7.6	6.6	7.3
ALL MANUFACTURING	48.7	46.9	52.4	53.2	48.5	42.1	43.7	44.7	42.8
ALL NONMANUFACTURING	1.3	1.3	1.2	1.0	0.9	0.9	0.8	0.8	0.8
ALL BUSINESS	21.4	19.7	19.7	18.9	17.7	16.4	17.0	17.0	16.1

Industry	1978	1979	1980	1981	1982	1983	1984	1985	1986
Iron & Steel	12.1	11.7	12.9	16.5	18.0	23.9	20.3	16.4	21.6
Nonferrous Metals	16.9	15.7	13.4	12.0	16.9	19.5	16.8	22.6	23.9
Machinery	57.7	47.5	51.7	49.8	58.3	62.1	62.8	67.9	78.6
Electrical Equipment	110.5	103.7	93.9	97.7	105.8	122.1	107.4	110.3	124.1
Aerospace	427.0	297.8	257.8	356.2	400.5	475.6	448.5	518.6	427.4
Autos, Trucks & Parts	55.8	56.0	56.7	48.9	61.8	73.2	54.4	48.1	72.0
Fabricated Metal Products	13.1	14.1	16.5	17.2	18.4	21.5	20.8	17.6	15.5
Instruments	181.7	176.5	181.1	178.5	191.1	246.3	210.6	205.4	238.0
Stone, Clay & Glass	10.3	8.9	10.2	13.5	16.0	18.2	17.2	16.0	17.4
Chemicals	46.1	41.2	39.9	42.9	52.6	56.3	52.4	52.8	53.6
Paper	10.2	8.5	7.6	9.2	11.2	11.7	10.5	9.6	10.2
Rubber	21.2	23.4	32.3	36.9	43.2	43.7	39.2	29.8	27.6
Petroleum	8.1	8.3	7.9	7.6	8.3	9.7	9.4	8.7	11.5
Textiles	6.8	7.1	7.5	7.0	8.5	8.1	7.2	8.6	9.4
Food	7.2	7.3	7.6	6.7	8.7	9.8	11.3	9.6	10.2
ALL MANUFACTURING	40.8	38.2	38.0	39.4	46.4	52.7	49.6	49.1	54.3
ALL NONMANUFACTURING	0.9	1.0	1.1	1.0	1.1	1.2	1.2	1.5	1.3
ALL BUSINESS	15.3	15.0	15.7	16.4	18.7	20.8	20.2	20.3	21.2

Table VII
Historical Research and Development Expenditures as a Percent of Sales

Industry	1953	1954	1955	1956	1957	1958	1959	1960
Iron & Steel	NA	NA	NA	NA	NA	0.5	0.5	0.6
Nonferrous Metals	NA	NA	NA	NA	NA	0.6	0.7	0.7
Non-Electrical Machinery	NA	NA	NA	NA	NA	3.3	3.5	3.5
Electrical Machinery	NA	NA	NA	NA	NA	10.4	10.5	10.8
Aerospace	NA	NA	NA	NA	NA	16.9	19.5	23.6
Autos, Trucks & Parts	NA	NA	NA	NA	NA	4.2	3.3	3.0
Fabricated Metals	NA	NA	NA	NA	NA	0.8	0.6	0.6
Instruments	NA	NA	NA	NA	NA	5.1	4.7	4.8
Stone, Clay & Glass	NA	NA	NA	NA	NA	0.8	0.7	0.8
Chemicals	NA	NA	NA	NA	NA	3.5	3.4	3.8
Paper & Pulp	NA	NA	NA	NA	NA	0.3	0.3	0.4
Rubber & Plastic	NA	NA	NA	NA	NA	1.3	1.4	1.5
Petroleum	NA	NA	NA	NA	NA	1.6	1.7	1.8
Textiles	NA	NA	NA	NA	NA	0.2	0.2	0.3
Food & Beverage	NA	NA	NA	NA	NA	0.1	0.1	0.2
ALL MANUFACTURING	NA	NA	NA	NA	NA	2.5	2.6	2.8

Industry	1961	1962	1963	1964	1965	1966	1967	1968
Iron & Steel	0.6	0.5	0.6	0.5	0.5	0.6	0.6	0.5
Nonferrous Metals	0.7	0.6	0.6	0.6	0.5	0.5	0.6	0.6
Non-Electrical Machinery	3.4	3.1	3.1	2.9	2.7	2.6	2.7	2.9
Electrical Machinery	9.9	9.4	9.8	9.9	9.3	9.1	9.2	9.0
Aerospace	24.5	24.9	27.9	30.3	29.4	26.0	22.1	20.8
Autos, Trucks & Parts	3.7	3.1	3.1	3.2	2.7	3.0	3.3	3.0
Fabricated Metals	0.6	0.6	0.6	0.5	0.4	0.4	0.4	0.4
Instruments	4.4	4.5	4.1	4.5	4.7	4.7	4.9	5.4
Stone, Clay & Glass	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9
Chemicals	4.1	4.1	4.0	3.8	3.7	3.5	3.6	3.5
Paper & Pulp	0.4	0.4	0.4	0.4	0.5	0.6	0.6	0.6
Rubber & Plastic	1.7	1.6	1.6	1.5	1.4	1.3	1.4	1.5
Petroleum	1.8	1.8	1.8	2.1	2.1	1.8	1.7	1.9
Textiles	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
Food & Beverage	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
ALL MANUFACTURING	2.9	2.8	2.9	2.9	2.8	2.8	2.8	2.8

Table VII
(Continued)

Industry	1969	1970	1971	1972	1973	1974	1975	1976	1977
Iron & Steel	0.5	0.6	0.6	0.5	0.4	0.4	0.5	0.5	0.6
Nonferrous Metals	0.5	0.6	0.6	0.5	0.5	0.5	0.8	0.7	0.6
Machinery	2.8	3.1	3.3	3.3	3.3	3.2	3.3	3.3	3.2
Electrical Equipment	9.1	9.0	9.1	8.8	8.0	7.6	8.0	7.6	6.7
Aerospace	21.9	21.3	21.8	23.5	20.2	19.4	19.7	20.8	21.7
Autos, Trucks & Parts	3.1	3.7	3.0	3.2	3.3	3.6	3.5	3.0	3.0
Fabricated Metal Products	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4
Instruments	5.7	5.7	5.5	5.4	5.4	5.1	5.3	5.3	5.4
Stone, Clay & Glass	0.9	1.0	0.9	0.8	0.8	0.8	0.9	0.9	0.8
Chemicals	3.5	3.7	3.6	3.4	3.3	2.9	3.0	2.9	2.7
Paper	0.8	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6
Rubber	1.6	1.7	1.6	1.8	1.7	1.7	1.7	1.6	1.2
Petroleum	1.9	2.1	1.9	1.6	1.4	1.1	1.0	0.9	0.9
Textiles	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Food	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
ALL MANUFACTURING	2.7	2.7	2.6	2.5	2.3	2.2	2.3	2.2	2.1

Industry	1978	1979	1980	1981	1982	1983	1984	1985	1986
Iron & Steel	0.5	0.6	0.7	0.8	1.5	1.7	1.4	1.4	1.7
Nonferrous Metals	0.5	0.5	0.5	0.5	0.7	0.6	0.6	0.8	1.0
Machinery	3.0	2.9	3.3	3.4	4.2	4.7	4.6	5.0	5.2
Electrical Equipment	6.5	6.7	7.1	7.4	7.9	8.8	8.4	8.9	8.6
Aerospace	20.2	16.6	15.8	18.5	20.6	18.5	20.4	19.7	16.4
Autos, Trucks & Parts	3.0	3.6	4.9	4.1	4.3	3.6	3.4	3.7	5.1
Fabricated Metal Products	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.4	0.5
Instruments	5.9	6.6	6.9	7.5	7.8	8.3	8.1	8.7	8.9
Stone, Clay & Glass	0.8	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0
Chemicals	2.8	2.7	2.9	3.1	3.9	4.0	4.0	4.4	4.6
Paper	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.9
Rubber	1.1	1.2	1.4	1.5	1.7	1.8	1.7	1.6	1.5
Petroleum	1.0	0.9	0.8	0.9	1.1	1.2	1.3	1.3	1.6
Textiles	0.2	0.2	0.2	0.2	0.3	0.2	0.3	0.3	0.3
Food	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3
ALL MANUFACTURING	2.1	2.1	2.3	2.5	2.9	3.0	3.1	3.3	3.4